COMPARATIVE STUDY BETWEEN GONIOSCOPY AND ULTRASOUND BIOMICROSCOPY IN MEASURING ANGLES OF ANTERIOR CHAMBER OF EYES

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CERTIFICATE

This is to certify that this dissertation entitled **"COMPARATIVE STUDY BETWEEN GONIOSCOPY AND ULTRASOUND BIOMICROSCOPY IN MEASURING ANGLES OF ANTERIOR CHAMBER OF EYES"** has been done by **DR. PALLAVI KAMATH P.** under my guidance in Department of OPHTHALMOLOGY, Madurai Medical College, Madurai.

I certify regarding the authenticity of the work done to prepare this dissertation.

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DECLARATION

I, **Dr. PALLAVI KAMATH P.** solemnly declare that the dissertation titled **"COMPARATIVE STUDY BETWEEN GONIOSCOPY AND ULTRASOUND BIOMICROSCOPY IN MEASURING ANGLES OF ANTERIOR CHAMBER OF EYES"** has been prepared by me.

This is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, in partial fulfillment of the requirement for the award of M.S.,(Ophthalmology) Branch-III degree Examination to be held in APRIL 2013.

Place : Madurai

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Last but not the least I thank God almighty for being my guiding light all the way.

CONTENTS

INTRODUCTION

Glaucoma is the most common cause of irreversible blindness and second leading cause of blindness[16]. It is characterized by optic neuropathy and visual function loss. Primary angle closure glaucoma is potentially preventable if diagnosis is done before irreversible damage. Hence to an ophthalmologist direct visualisation of the angle of anterior chamber of eyes is of crucial importance. Aqueous outflow occurs through the angles and should be studied as an important structure of eyes.

Ultrasound biomicroscopy and gonioscopy are the two important measures to study angles of anterior chamber of eyes.

Gonioscopy is a subjective method of study of anterior chamber angles of eyes, it is considered as the gold standard technique. It is an integral part of diagnostic evaluation and is done routinely in all patients with glaucoma. It is often associated with misdiagnosis and under detection of angle closure.

Ultrasound biomicroscopy has revolutionised the evaluation of eye i.e. the anterior segment to understand the path of angle closure glaucoma, pigmentary glaucoma. It also helps in quantitative analysis to yield mechanism of oppositional angle closure and dynamic function of the iris. Hence early detection and treatment of angle closure significantly improves visual prognosis.

Ultrasound biomicroscopy is more established technique which allows a more objective assessment of anterior segment status. Recently used in objective measurement of anterior chamber angles. Also used to study anatomic configuration of the angle structures of the normal eyes and the glaucomatous eyes.

Advantage of ultrasound biomicroscopy is high image resolution. It also allows accurate identification of structural landmarks. It is used to measure angle parameters and also to quantify the data acquired.

ANATOMY

Pathophysiology of glaucoma revolves around the aqueous humour dynamics. The principal structures in the eyes concerned with this aqueous humour dynamics are ciliary body, angle of anterior chamber and aqueous outflow system.

CILIARY BODY:

Aqueous humour formation is a biological process that is subjected to circadian rhythm. Ciliary body is the forward continuation of the choroid at the ora serrata. It is triangular in shape. Consist of two parts; par plana, pars plicata. Pars plicata is the anterior finger like process. Pars plana is the posterior smooth part. The ciliary process is the seat of aqueous production, each of which is composed of double layer of epithelium over a core of stroma and a rich supply of fenestrated capillaries. 80 such processes are present supplied by branches from major arterial circle of the iris. Each process is 2mm long. It is 0.5 mm in diameter.

The apical surface of both outer pigment epithelium and inner non pigment layer of epithelium face each other joined by tight junction is a part of blood aqueous barrier. The inner non pigment epithelial cells are thought to be the actual sight of aqueous humour production. Ciliary process provides a large surface area for secretion.

The aqueous produced from the ciliary process passes from the posterior chamber to the anterior chamber to drain into the episcleral veins through angle of the anterior chamber of eyes. The posterior chamber of the eyes contains about 0.06ml of aqueous. The anterior chamber of the eye contains about 0.25ml aqueous.

ANGLE OF ANTERIOR CHAMBER OF EYES:

This plays an important role in process of aqueous humour drainage. It is formed by the route of the iris, anterior most part of the ciliary body, sclera spur, trabecular meshwork and schwalbe's line (prominent end of Descemet's membrane of the cornea). It is based on these angle structures where the glaucoma is classified.

The angles can be measured with the instrument called gonioscope.

The ciliary body band is the most posterior landmark in the angle recess. It is the anterior most part of the ciliary body at the insertion of iris and attachment to sclera spur. The sclera spur is the posterior portion of the sclera sulcus. Ciliary body is attached to it. The trabecular meshwork is like a band anterior to the sclera spur. Gets pigmented as the age increases. Schwalbe's line is a fine ridge in front of the trabecular meshwork. It is the prominent end of descemet's membrane of the cornea.

AQUEOUS OUTFLOW SYSTEM:

It includes trabecular meshwork, Schlemm's canal, collector channels, aqueous veins, episcleral veins.

1. Trabecular meshwork: it is a sieve like structure through which aqueous leaves the eye. It has three layers.

    a) Uveal meshwork: extends from iris to schwalbe's line. Pore size of 25µ

b) Corneoscleral meshwork: extends from sclera spur to sclera sulcus. Pore size of 5-50µ

c) Juxtacanalicular meshwork : near the trabecular meshwork. Narrowest part offering resistant to the aqueous outflow system.

2. Schlemm's canal: these are endothelial lined oval channels lying circumferentially in the scleral sulcus. Inner part is irregular with giant vacuoles outer part is smooth and continuous with the opening of collector channels.

3. Collector channels: also called as intrascleral aqueous vessels. They are 25-35 in number. They are 2 systems in eyes.

   a. Direct system : large vessels which run a short intrascleral course and drain directly into episcleral veins

   b. Indirect system: small collector channels which form intrascleral plexus before going to episcleral vessels.

4. Episcleral veins: aqueous vessels drains into it.

PHYSIOLOGY

Aqueous humour formation and secretion occurs as a result of

- Active secretion
- Ultra filtration
- Simple diffusion

Active secretion accounts for majority of aqueous production. It is the energy required to move the substance against the electro chemical gradient and is independent of pressure. It occurs in double layer of ciliary epithelium.

Ultra filtration is a pressure dependant movement of substance along the pressure gradient. In ciliary process, the hydrostatic pressure difference between the capillary pressure and intraocular pressure favours fluid movement into the eye whereas the difference in oncotic pressure resists the fluid movement.

Diffusion is the passive movement of ions across membrane related to charge and concentration.

Ultra filtration and diffusion primarily operates against the concentration gradient, the passive mechanisms of aqueous formation are dependent on the level of blood pressure in the ciliary capillaries, the plasma oncotic pressure and the level of intra ocular pressure.

Rate at aqueous humour formation depends on

a. Integrity of blood aqueous barrier
b. Neurohumeral regulation of vascular tissue and ciliary epithelium.
c. Blood flow to the ciliary body

Normal rate of aqueous formation: 2.3µl/min

The outflow system can be of two types:

1. Trabecular (conventional) outflow: it comprises of 70-80% drainage. It is the main outlet of aqueous from the anterior chamber. Aqueous transport across the inner wall is partially understood. Vacuolation theory is accepted one, according to which transcellular spaces exists in the endothelial cells lining the inner wall of Schlemm's canal. It opens as

vacuoles and transports aqueous from juxtacanalicular connective tissue to Schlemm's canal.

2. Uveoscleral (unconventional) outflow it comprises of 20-30% of drainage. Aqueous passes across ciliary body muscles into suprachoroidal space and is drained by venous circulation of ciliary body, choroid and sclera.

VARIOUS MECHANISM OF AQUEOUS TRANSPORT

- Vacuolation theory: vacuoles are present in the endothelium which opens and closes intermittently transporting aqueous from juxtacanalicular tissue to Schlemm's canal.
- Leaky endothelial cells: these cells leads to aqueous drainage.
- Sonderman's channels: small tubules which connect inner trabecular spaces of the corneoscleral meshwork to the lumen of Schlemn's canal for aqueous drainage.
- Contractile microfilaments: exact mechanism not known. They are found in schlemn's canal and trabeculae.

- Pores in endothelial cells : they are responsible for the bulk of the outflow of aqueous humor.

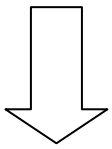
Normal intraocular pressure: 16±2.5mmHg

Intraocular pressure is maintained by dynamic equilibrium between formation and outflow of aqueous humour.

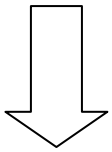
Glaucoma is a group of disorder characterised by progressive optic neuropathy resulting in characteristic appearance of the optic disc and a specific pattern of irreversible visual field defect[16]. Intraocular pressure is the most common risk factor

DRAINAGE OF AQUEOUS

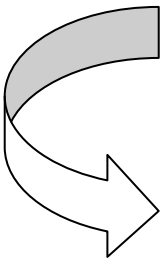
CILIARY PROCESSESS

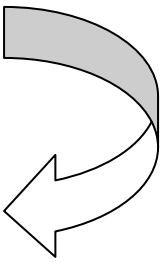


AQUEOUS HUMOUR IN POSTERIOR CHAMBER



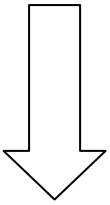
ANTERIOR CHAMBER

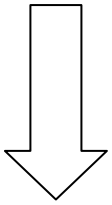




TRABECULAR MESHWORK

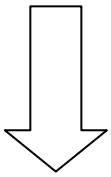
UVEAL MESHWORK

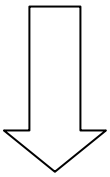




SCHLEMM'S CANAL

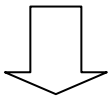
SUPRACHOROIDAL SPACE

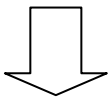




COLLECTOR CHANNELS

VENOUS CIRCULATION





TRABECULAR OUTFLOW

UVEAL OUTFLOW

GONIOSCOPY

Gonioscopy involves visualisation of the angle of the anterior chamber, the site at which aqueous begins to exit from the eye and helps in differentiating important types of glaucoma from each other and directing the clinician towards the appropriate treatment in each case.

It is not possible to see the iridiocorneal angle in a normal eye directly as the angle of incidence of light coming from the angles is more than 46°, which is the critical angle for cornea air interface resulting in total internal reflection. Gonioscopy is an investigative tool that obviates air corneal interface thus allows light from the angles to exit the eye.

"TRANTAS" first coined the term "gonioscopy"[2].

"SALZMANN" was first to perform direct gonioscopy and is known as the FATHER OF GONIOSCOPY[2]. "GOLDMAN" was the first to introduce gonioprisms[2].

Types of gonioscopy:

1. Direct
2. Indirect

In direct gonioscopy the angle is viewed directly. The direct goniolenses have steeper curvature than the cornea, so light rays are reflected at the corneal air interface in such a way that critical angle is not reached.

In indirect gonioscopy angle is viewed in the mirror mounted on a gonioprism, so that light rays are reflected from the mirror and leave the lens at right angles.

Direct gonioscopic lens examples[2]:

1. KOEPPE	PROTOTYPE DIAGNOSTIC GONIOLENS
2. RICHARDSON SHAFFER	FOR INFANTS
3. LAYDEN	FOR PREMATURE INFANTS
4. HOSKINS BARKAN	PROTOTYPE SURGICAL AND DIAGNOSTIC LENS
5. THORPE	FOR OPERATING ROOM
6. SWAN JACOB	SURGICAL LENS FOR CHILDREN

Indirect gonioscopic lens example[2]:

1. GOLDMANN SINGLE MIRROR	MIRROR INCLINED AT 62°
2. THORPE FOUR MIRROR	4 MIRROR INCLINED AT 62°
3. ZEISS FOUR MIRROR	MIRROR INCLINED AT 64° REQUIRES A HOLDER
4. POSNER FOUR MIRROR	MODIFIED ZEISS WITH ATTACHED HANDLE
5. SUSSMANN FOUR MIRROR	FINGER HELD
6. GOLDMANN THREE MIRROR	MIRROR FOR GONIO 59°
7. RITCH TRABECULOPLASTY LENS	2 MIRROR AT 59° AND 2 MIRROR AT 62°

USES OF GONIOSCOPY:

2. DIAGNOSTIC:

- For visualisation of angle of the anterior chamber angle
- historical evidence of glaucoma,
- For classification of glaucoma
- To note the extent of iris neovascularisation

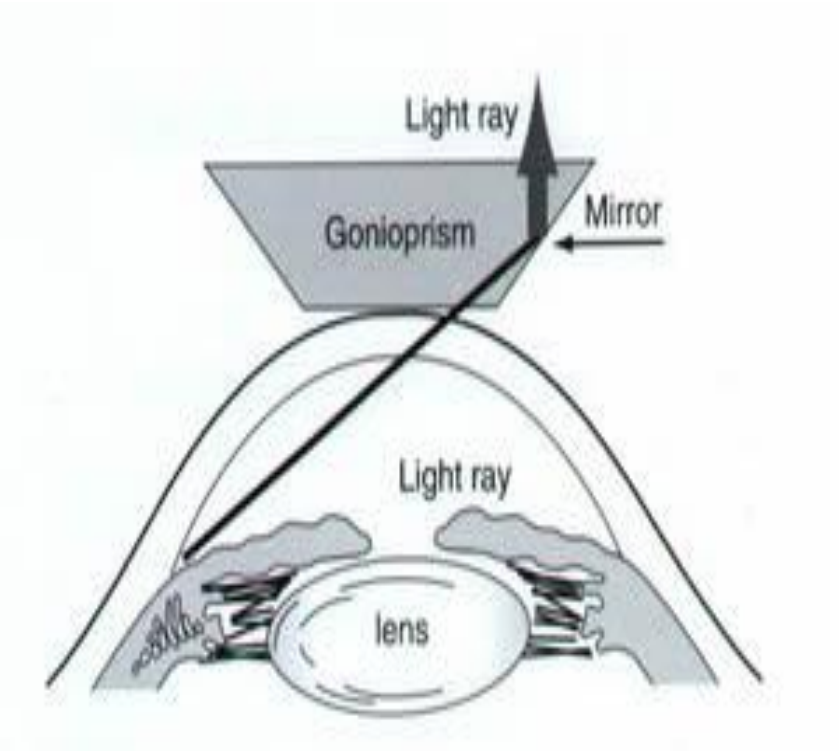
- To assess angle recession
- History or evidence of inflammation
- For evidence of neoplastic activity
- For developmental anomaly
- For planning treatment for iris neovascularisation and laser procedures

3. THERAPEUTIC:

- Argon laser trabeculoplasty
- Laser goniotomy
- Reopening of the trabecular opening.

Primary angle closure disease is a major cause of blindness. Screening for angle closure disease therefore assures great importance in reducing the burden of blindness due to glaucoma in certain population.

GONIOSCOPE



NORMAL GONIOSCOPIC FINDINGS

Structure seen from anterior to posterior[2].

A. CORNEA

B. SCHWALBE'S LINE: this structure is opaque and white located where Descemet's membrane ends in a circumferential ring of collagenous fibres. It can be identified by following ways

- It is a transition between transparent cornea and off white translucent tissue of trabecular meshwork.

  Between steeper curvature of cornea and flatter curvature of sclera

- Self like prominence

- Parallelepiped method: a thin slit of light inclined from the angle is thrown, so that 2 separate corneal light reflexes are appreciated, one on inner aspect of cornea other on the outer aspect. These light reflexes form a corneal wedge.

C. **TRABECULAR MEHWORK :**

Normal width is 0.5mm. It has porous and textured appearance. It consists of two parts, anterior non pigmented part and posterior pigmented part. Anterior part is made up of fibres continuous with the iris insertion. Posterior part consists of more densely packed fibres which extend from cornea to the scleral spur.

D. **SCLERAL SPUR:**

It is the most definite land mark of the angle of anterior chamber of eyes. It is the prominent internal extension of sclera which is whiter and less translucent compared to trabecular meshwork. It forms the anterior wall of the sclera pocket where Schlemm's canal rest.

E. **CILIARY BODY:** It is seen as a light grey to dark brown band.

WIDE CBB		NARROW CBB
PHYSIOLOGICAL	PATHOLOGICAL	HYPEROPIA
MYOPIA	ANGLE RECESSION	ANTERIOR IRIS INSERTION
APHAKIA	CYCLODIALYSIS	

F. **IRIS:** Two things are to be noted

- Configuration: convex / concave / prominent last iris roll.
- Insertion of iris: normally below sclera spur into ciliary body.

Gonioscopy must be utilized for accurate assessment of angles. First determine whether the angles are open or closed. Then they can be graded using Shaffer's grading system[10].

GRADING ACCORDING TO SHAFFER'S[10]

GRADE 0 : 0˚ (closed angle) inability to identify apex of corneal wedge

GRADE 1 : 1-10˚ (very narrow) only schwalbe's line visible

GRADE 2 : 11°-20˚ (moderately narrow) closure possible, trabecular meshwork visible

GRADE 3 : 21˚-35˚ (open angle) scleral spur is visible

GRADE 4 : 35˚-45˚ (wide open) ciliary body band can be visualised

Gonioscopy records the angles in degrees of arc subtended by two imaginary tangential lines drawn to inner surface of the trabecular meshwork and anterior surface of iris.

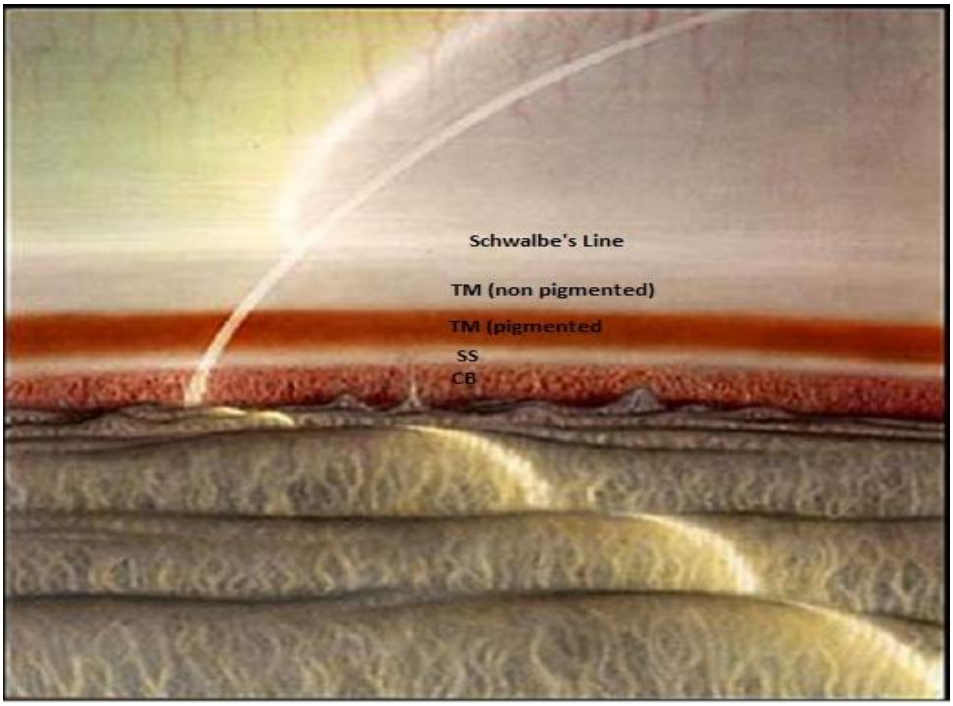
Other methods of angle grading are

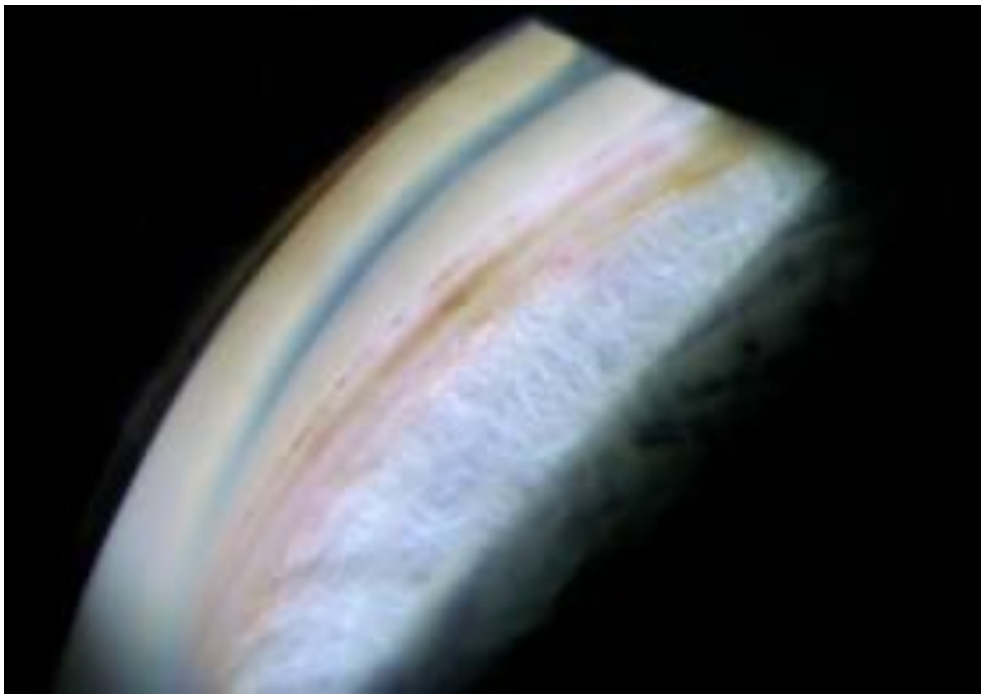
a. Scheie's system[17,18]

b. Spaeth system[17,1820]

c. RPC system[17]

GONIOSCOPIC VIEW OF ANGLE STRUCTURES





Spaeth system of grading[17,18,20]

It has the following components :

a. Iris configuration

q: Queer

r: regularly straight iris

s : steeply convex iris

b. Iris processes

U along angle recess

V upto the trabecular meshwork

W upto the schwalbe’s line

c. Level of iris insertion

A anterior to schwalbe’s line

B behind the schwalbe’s line

C at the scleral spur

D deep angle Ciliary Body Band seen

E extremely deep angle.

d. Angular width – 10º, 20º, 30º, 40º

e. Pigmentation of posterior trabecular meshwork

0: no visible pigmentation

1+: just perceptible pigmentation

2+: definite but mild

3+: moderately dense

4+: dense black pigmentation

RPC system of grading of the angles[2]

Grade 0: closed

Grade1: schwalbe's line

Grade2: anterior trabecular meshwork

Grade3:posterior pigmented trabecular meshwork

Grade4: scleral spur

Grade5: ciliary body band

Grade6: root of the iris

SCHEIE system of grading of the angles[27, 33]:

Grade 0: CBB seen , no angle closure

Grade1: CBB narrow, no angle closure is seen

Grade2: CBB not seen, SS seen, rarely closure possible

Grade3: posterior TM not seen, closure is likely

Grade4: Schwalbe's line not seen, gonioscopically closed.

DYNAMIC GONIOSCOPY:

It is of two types:

- Indentation gonioscopy: to differentiate between appositional and synechial closure. Done with 4 mirror lenses. Introduced by Forbes. In this the central cornea is pressed leading to increase intra ocular pressure. This stretches the limbal ring, straightening the corneoscleral angle. This will lead to partial rotation of iris and the ciliary body. Aqueous is pushed out of the angles, pushing the iris posteriorly and opening the angles. If trabecular meshwork seen in previously closed angles on pressure it is said to be

appositional. This maneuver can also be used to break an attack of angle closure

- Manipulation gonioscopy: it is done to view over the convex iris known as “over the hill” view or “dive bombers view”. In this procedure the mirror is tilted towards the angle to be viewed, the patient is asked to look in the direction of mirror.

Procedure:

Patient is positioned on slit lamp with anaesthetised cornea. Methylcellulose or saline is used to fill the concave surface of the goniolenses. Patient is asked to look up then the lens is positioned and asked to look down the lens remains in position by the suction effect well centered.

To view the angle, the illumination lamp and microscope should be placed perpendicular to the pupil. Slit lamp beam used should have least illumination and magnification. Width of the beam should be 2 mm size. Light should not fall over the pupillary area.

Sterilisation:

Guidelines by American academy[1]:

- Invert the contact lens
- Wipe the lens with alcohol sponge
- Fill concave area with 1:10 solution of household bleach
- Leave for 5 minutes
- Rinse with water

ULTRASOUND BIOMICROSCOPY

ULTRASOUND:

Sound is transmitted through media as “longitudinal waves”. The particles in the medium move parallel to the direction of wave propagation. The molecules of media move back and forth. Thus producing bands of compression and rarefactions. Each repetition of this motion is called as a “cycle” and each cycle produces a new wave.

The “wavelength” is the distance between compression and rarefaction band.

VELOCITY OF SOUND

Sound requires medium for its transmission .Velocity of sound beam depends upon the nature of the medium. The particles in the sound beam oscillate back and forth and the velocity of sound is determined by the rate at which the force is transmitted from one particle to another.

So sound travels fastest through solids and slowest through gases and a velocity in between through liquids.

The 2 important factors of media affecting velocity of sound through them are:

1) Compressibility

2) Density

COMPRESSIBILITY:

Velocity of sound is inversely related to the compressibility of the media, so the lesser the compressibility of the media, the greater is the velocity of sound through it.

DENSITY

Velocity of sound is directly proportional to the density of the conducting media.

INTENSITY OF SOUND

“Defined as amount of energy in joules transported each second through each square of media perpendicular to the direction in which the sound is travelling”.

Intensity of sound or loudness in the audible range is determined by the length of oscillations of particles conducting

the waves. The greater the amplitude of oscillation, the more intense the sound. Intensities are expressed in watt (power) per square meter.

DECIBLE SCALE:

The intensities must be compared by calculating the ratio of one to the other. A logarithmic scale “the decibel dB scale” has been adapted. On this intensity level in dB of intensity of our sound wave is compared with reference intensity in equation. A negative dB value thus represents an attenuation or reduction of intensity.

CHARACTERISTIC OF ULTRASOUND

FREQUENCY:

The frequency of a sound wave is the number of oscillation or cycles per second measured in Hertz (Hz).

For the sound to be considered “ultrasound”, it must have a frequency greater than 20000 oscillation per second or 20 KHz, rendering it inaudible to human ear.

WAVELENGTH:

A direct relationship exist between the wavelength and depth of penetration, so shorter the wavelength the more shallower the penetration. However as the wavelength shortens, the image resolution improves. Given that for general ophthalmic examination for deeper penetration lower frequencies are used as in case of evaluation of anterior chamber structures with high resolution is achieved by high resolution ophthalmic B scan probes.

Hence ultrasound biomicroscopy or UBM have been manufactured of 20-50MHz and penetrate only about 5-10 mm

into the eye for incredibly detailed resolution of the anterior segment.

VELOCITY IN OCULAR TISSUES:

There are known velocities of different components of the eye.

Velocity through aqueous and vitreous: 1532m/s

Velocity through cornea and lens: 1649m/s

Velocity through blood and hyphema: 1550m/s

If the eye is scanned through a fluid medium (usually normal saline) with open eyelids, extreme high frequencies can be used because of the lack of attenuation by intervening tissues.

REFLECTIVITY:

When sound travels from one medium to another of different density, part of the sound is reflected from the interface between those media back into the probe this is known as an echo.

The greater the density difference between the media, stronger the echo or higher the reflectivity. The image is produced by the reflected portion of ultrasound wave.

In A scan ultrasonography, a thin parallel sound beam is emitted which passes through the eye, the echoes of which are represented by spikes arising from baseline. The stronger the echoes of which are represented by spikes arising from the baseline. The stronger the echo, higher the spike.

In B scan ultrasonography, an oscillations beam is emitted imaging a slice of the tissue, the echoes of which are represented as the multitude of dots that form an image on the screen. The stronger the echo, the brighter the dot.

The percentage of beam reflected at tissue interfaces also depend on tissues acoustic impedance and the angle of incidence of the beam.

ACOUSTIC IMPEDANCE:

It is a fundamental property of matter. The impedance of a material is the product of its density and the velocity of sound in the material.

UNITS OF IT BEING RYLES.

Z = pv

Z = acoustic impedance (Ryles)

P = density (gm/cm^3)

V = velocity (cm/sec)

A substance's acoustic impedance is the constant.

The angle of incidence is critical for both B scan and A scan ultrasonography.

When the probe is held perpendicular to the area of interest, more echoes are reflected back directly into probe and sent to the display screen.

Ultrasound biomicroscopy is an indispensable tool in medical imaging and has an important tool in ophthalmologic

diagnosis. It is a recent technique to visualise anterior segment.. Ultrasound biomicroscopy is performed with a 50 MHz probe. Uses high frequency ultrasound transducer. The resolution of 50MHz is 40μ and depth is 4mm.

Dr. Charles Pavlin and Prof. Stuart Foster developed ultrasound biomicroscopy. It was done at Princess Margaret Hospital at Toronto, Canada.1989. 50, 80, 100MHz probe was used[5]. 50MHz probe was considered ideal compromise between depth and resolution to visualise the entire anterior segment of the eyes. The first commercially available machine was developed by Zeiss in 1991.

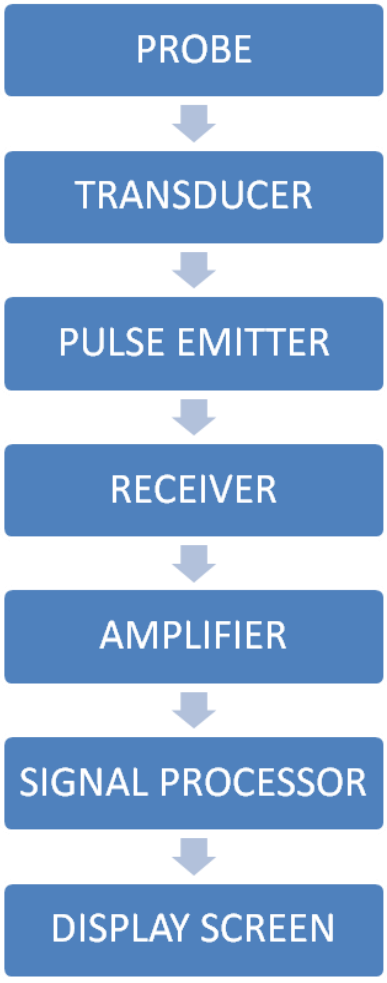
INSTRUMENTATION

Uses pulse echo system.

PARTS OF THE INSTRUMENT[5]:

3 Main components of ultrasound biomicroscopy machine are

1. High frequency signal processing
2. Transducer
3. Precise motion control



PROBE:

Face of the probe is oval in shape housing for appropriate piezoelectric crystal disc called immersion probe. Probe speed is 100-225msec/ scan.

TRANSDUCER:

35MHz or 50MHz. Frequency of 50MHz means that a radiofrequency pulse of 50MHz is generated by piezoelectric crystal of the transducer. Thus radiofrequency travels the body tissue and reflects back to the transducer. The penetration of the 50MHz ultrasound biomicroscopy transducer is poor hence the ultrasound biomicroscopy transducer has an open crystal and there is no membrane covering it as in the B scans. The signal processing unit in ultrasound biomicroscopy handles high frequency signals. In the ultrasound biomicroscopy movement of the transducer have to be subtle to scan adjacent areas in the anterior segment. There is a special motion control device for the transducer.

The transducer is mounted on the pulley with piezoelectric crystals fixed on a large handle this is to facilitate subtle movement.

PIEZOELECTRIC EFFECT:

It is the heart of ultrasound biomicroscopy instrument

Piezoelectric effect has 2 complimentary attributes. They are

1. Pressure is exerted to squeeze the crystal; an electric voltage is developed between opposite faces. No pressure, no voltage. Reversed direction pressure, voltage is reversed.
2. If voltage from an external source is connected across the crystal, it causes the crystal to change in the form of deformation or strain. When voltage is reversed in polarity strain is also reversed. This property is used to generate ultrasound.

PIEZO ELECTRIC MATERIALS:

A number of naturally occurring crystalline materials display the property of piezoelectricity. Examples Rochelle salts, quartz.

Piezoelectric polymers like poly vinyl fluoride and copolymer have low acoustic impedance and is said to be ideal for acoustic matching of the transducer to the soft tissues.

PULSE EMITTER:

This unit is responsible for the electric signal converted into sound wave by the transducer. Electricity is sent in pulses hence the name.

RECEIVER:

In between emission of sound the receiver receives the signals that transducer hears. Sound waves reflected are converted to electric signals and sent to the amplifier.

AMPLIFIER:

Enlarges echo signal sent from signal processor. It amplifies signals from deeper structure, it compensates for attenuation of ultrasound beam in the tissue.

SIGNAL PROCESSOR:

Detects echoes and filters noise.

DISPLAY SCREEN:

It produces two dimensional view of the anterior segment. Represented by bright spots on dark background.

UBM PROBE

NORMAL STRUCTURES SEEN IN ULTRASOUND BIOMICROSCOPY

The high resolution cross sectional images acquired by the ultrasound biomicroscopy are akin to an in vivo histological section.

ANTERIOR CHAMBER:

Can be measured by using ultrasound biomicroscopy. Depth is measured as the axial distance between corneal surface to lens surface. Measurement can be taken anywhere.

CORNEA:

All layers can be differentiated. The first highly reflective surface of cornea is the epithelium. Epithelium can be differentiated from Bowman's membrane which can be differentiated as a highly reflective line below the epithelium. The difference between the above two gives the epithelium thickness. Endothelium and the Descemet's membrane form a single highly reflective line. The stroma shows low internal reflectivity. The

corneoscleral junction can be differentiated by point of junction of low with high internal reflectivity.

ANTERIOR CHAMBER ANGLE REGION:

Sclera spur is a constant reference point for measurement of angle of anterior chamber of eyes. The corneoscleral junction and scleral spur can be distinguished consistently with ultrasound biomicroscopy.

IRIS:

Normally shows variation in thickness, it is thin at its insertion and thick at pupillary border. The epithelium of iris is constantly highly reflective. The posterior border of iris is also highly reflective hence can be used to differentiate the intra iris lesions from lesions behind the iris.

CILIARY BODY:

It is well defined by ultrasound biomicroscopy. The ciliary processes can be of variable configuration and length. Zonules can be seen on the lens surface inserted smoothly.


Normal Anterior Chamber Anatomy
Cornea
Sclera
Schwalbe's line
Scleral spur
Anterior chamber
Pars plana
Iris
Posterior chamber
Pars plicata
Anterior lens capsule
0.5mm
NYEEI, Ocular Imaging Center

USES:

- Glaucoma: to study angle structures in detail even in the presence of opaque medium. Angles can be quantified and quality can be assessed.
- Trauma: to check the position of lens status in the presence of hyphaema. To visualise iris and ciliary body , any cyclodialysis, iridodialysis and angle recession
- Pupillary block: when iris is bowed forward and the angles are occluded. Relieved on laser iridectomy.
- Plateau iris: anteriorly placed ciliary process which pushes the iris up and blocks the trabecular meshwork.
- Laser iridotomy: effectiveness of iridotomy to eliminate pupillary block and push the iris backward.
- Iris and ciliary body cyst: extremely useful for seeing structures behind the iris.
- Uveitis: for pars planitis, supraciliary effusion, cyclitic membranes, ciliary body detachment

- Tumours : to diagnose the extent and characterise the tumours of the anterior segment.
- Opaque media: to visualise anterior segment in the presence of opaque media.
- Scleritis: differentiates scleritis from episcleritis.

QUALITATIVE ULTRASOUND BIOMICROSCOPY IN GLAUCOMA:

The ability of the ultrasound biomicroscopy to image structural abnormality on a much finer scale than previously it has been used as a new quantitative tool for research and clinical assessment of glaucomatous eyes. It helps in study of the angles with great detail. The exact configuration can be defined. The angle structures can be seen even in the presence of opaque cornea.

Angle closure glaucoma is caused by iris opposition to the trabecular meshwork which is the final pathway. It can occur due to various abnormalities in the anterior segment structures. Forces generated for angle closure are at 4 different sites.

a) iris : pupillary block, b)the ciliary body : plateau iris, c)the lens: phacomorphic glaucoma d) by combination of forces. Differentiating these varieties of causes helps in effective treatment of glaucoma. UBM is extremely useful in achieving this goal. The only variety of open angle glaucoma showing

characteristic feature in UBM is pigmentary glaucoma, there is posterior bowing of the iris specific to this glaucoma.

QUANTITATIVE ULTRASOUND BIOMICROSCCOPY IN GLAUCOMA

UBM permits reproducible imaging of the anterior chamber angle. It helps in quantification of the anterior chamber angles. It can determine the state of angle closure not detected by gonioscopy. Pavlin et al[14,15] defined different UBM parameters to characterise the anterior chamber angle. They are

1) Angle opening distance(AOD): this is "defined as the distance from the corneal endothelium to the anterior iris, perpendicular to the line drawn from trabecular meshwork , at a fixed distance from the sclera spur". A distance of 250µ would fall on the trabecular meshwork which is given as AOD 250. A distance of 500µ from sclera spur would measure the angle opening anterior to the trabecular meshwork which is given as AOD500. This measurement reflects the amount of relative pupillary block in narrow angles.

2) The trabecular ciliary process distance(TCPD): “it is measured from a point on the trabecular meshwork, 500µ anterior to the scleral spur, extended perpendicularly through the iris and the ciliary process”. This is the space available for the iris between the trabecular meshwork and ciliary process and is typical to individual eye. An anteriorly placed ciliary process or thick iris reduce the peripheral anterior chamber depth and make it susceptible for occlusion.

3) Trabecular iris angle TIAθ 1: Pavlin et al[14,15] defined angle in degrees to proposing to draw a superior line through trabecular meshwork and inferior line along the iris and hence measuring the angle between, which is formed at the apex of the fusion of two lines.

4) Iris thickness

ID1: iris thickness 500µm anterior to the sclera spur.

ID2: iris thickness 2mm from the iris root

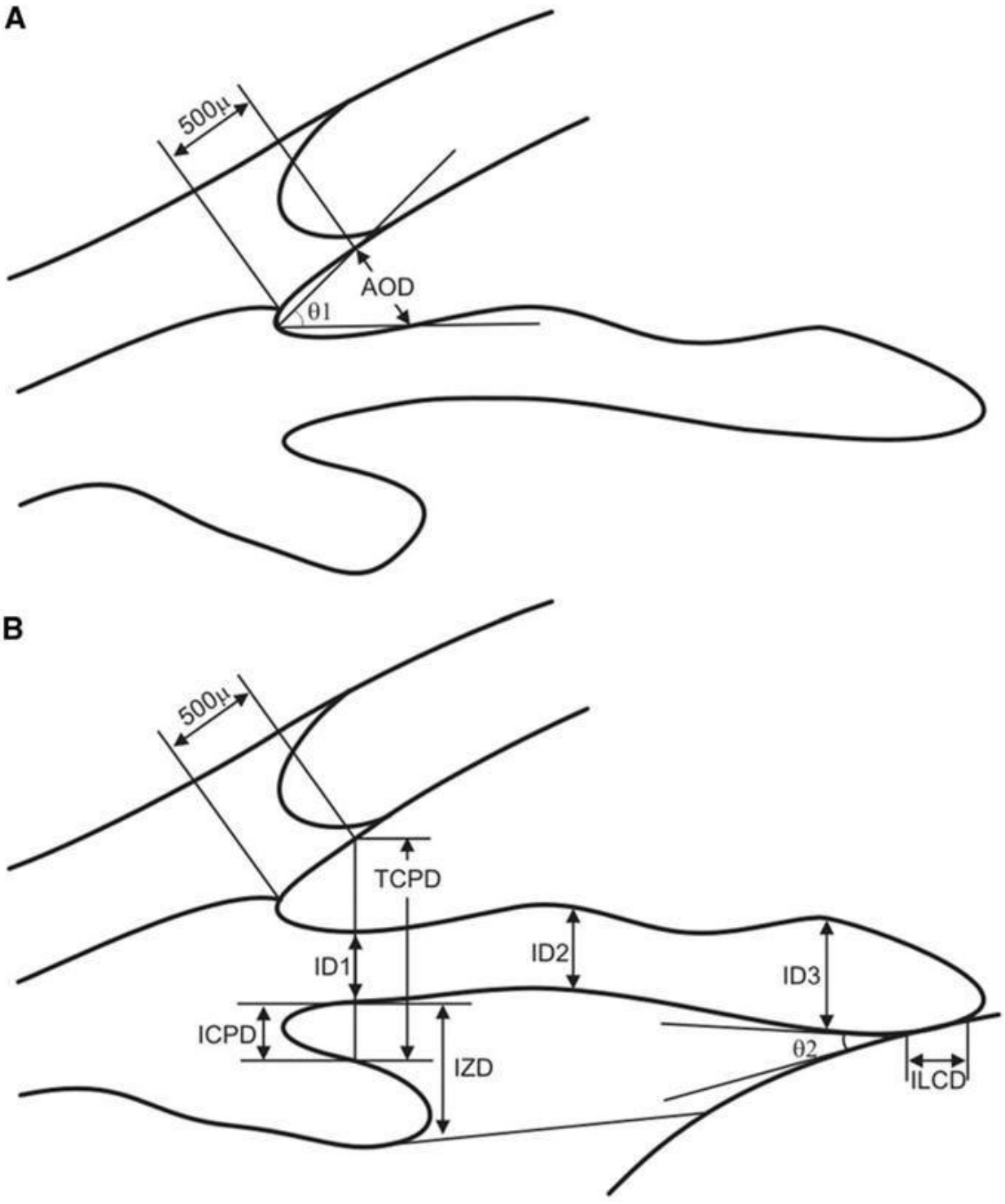
ID3: from the pupillay area maximum iris thickness

5) Iris lens contact distance ICLD: contact distance between iris and the lens.

6) Iris zonule distance IZD: distance between the iris and zonule along the line of trabeculociliary process distance.

7) Iris ciliary process distance ICPD: distance between iris and ciliary process along the line of trabeculociliary process distance

8) Iris lens angle ILAθ2: angle between iris and lens near pupillary edge.


A
500μ
AOD
θ1
B
500μ
TCPD
ID1
ID2
ID3
ICPD
IZD
θ2
ILCD

The angles can be graded by SHAFFER'S GRADING.

GRADE ACCORDING TO SHAFFER'S GRADING[10]

GRADE 0 : 0˚ (closed angle) inability to identify apex of corneal wedge

GRADE 1 : 10˚ (very narrow) only schwalbe's line visible

GRADE 2 : 20˚ (moderately narrow) closure possible, trabecular meshwork visible

GRADE 3 : 25˚-35˚ (open angle) scleral spur is visible

GRADE4 : 35˚-45˚ (wide open) ciliary body band can be visualised

PROCEDURE:

Ultrasound biomicroscopy is performed in the same settings as the gonioscopy but in supine position. The patient is explained about the procedure and its purpose. Since the piezoelectric crystals of the transducer are open they should not come in direct contact with the eye in order to prevent injury to the cornea.

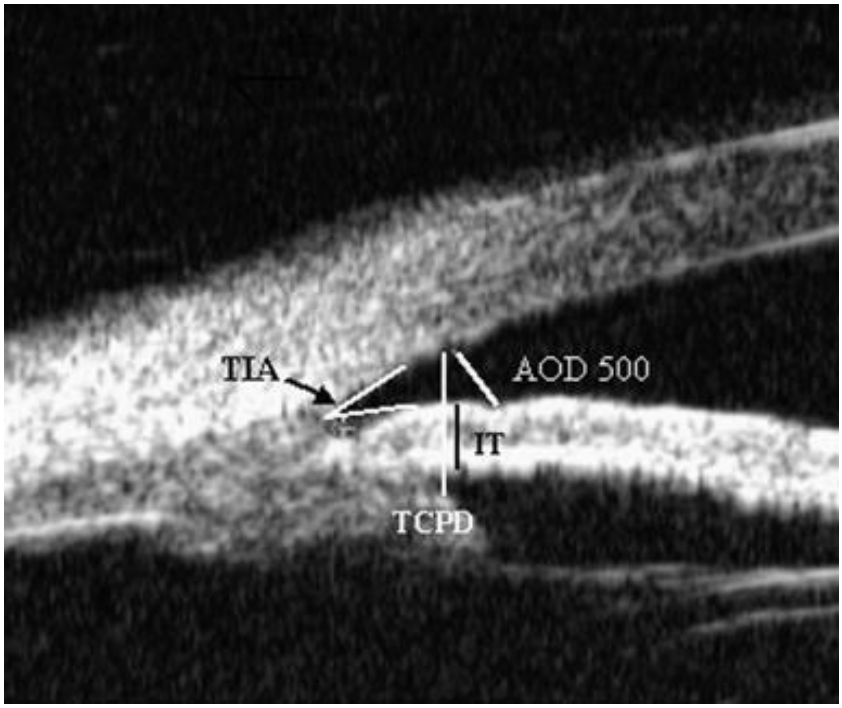
Hence a special cup is used to fit the lids to keep it open. They come of various sizes.

The eye cup is filled with saline or sterile methyl cellulose. The crystal of the transducer is placed in saline approximately 2mm from the eye surface. This distance is to prevent corneal injury during the procedure. The eye is scanned in each clock hour. 12, 3, 6, 9 are scanned to view the angles.

TECHNIQUE:

- Attach the ultrasound biomicroscopy to the cable connector to match with the red dot on the probe and red dot on the connector.
- Remove the cap if in position covering the probe.
- Attach the transducer into the probe, avoid over tightening as it may break the thread.
- Open the eyelids and place the cup over the anaesthetised cornea and soft tissue.
- Fill the cup with saline 18 – 24ml.
- Keep the probe little above the cornea during the procedure.

- After finishing the procedure remove the saline from the cup with syringe without needle.
- Gently place the probe back into the holder.



STERILISATION:

1. Remove the transducer from the probe and check for debris and gently wipe it.
2. Immerse the transducer and probe tip in the cidex solution for 20 min.
3. Remove all the cidex residues by rinsing it again.
4. Store in a sterile container for next use.

Do not use substances like

Saline solution, tap water, sodium hypochlorite, rough cloth.

LIMITATIONS:

- Depth is one of the major limitations as it can not visualise more than 4 mm from the surface
- Very expensive
- In the presence of open corneal wound procedure should not be done.
- Can be done in supine position only.

REVIEW OF LITERATURE

A study done by Sushmita Kaushik et al in Indian journal of ophthalmology on evaluation of anterior chamber of eyes showed out of 163 patients analyzed, 106 eyes had narrow angles and 57 eyes had open angles on gonioscopy. There was significant difference among the mean UBM measurements with gonioscopy, Each angle grade estimated by both method p value<0.001. The mean values were as follows AOD 250: 58±49µ, AOD 500: 102 ±84µ and TCPD in narrow angles 653±124µ, while it was AOD 250: 176±47µ, AOD 500: 291±62µ and TCPD : 883±94µ in eyes with open angles respectively .This study proved that estimation of angle depth by gonioscopy was inaccurate in narrow angles which included slit like and grade1 angles while grade 2 & 3 was fairly accurate. Subjective method of gonioscopy was helpful in differentiating occludability from non occludability. It causes over diagnosis of occludable angles However UBM is an objective method for quantifying angles and can be considered as a reliable parameter to grade angle width. The angle width estimated with

gonioscopy correlated significantly with angle dimension measured by UBM[12].

Agreement between gonioscopy and ultrasound biomicroscopy in detecting iridiotrabecular apposition by Yaniv Barkan et al[3] in Arch Ophthalmology 2007 showed angle in all 18 eyes seen in dark room illumination gonioscopy one eye showed iridiotrabecular apposition where as in UBM 56% of the cases showed apposition in room light. According to this study gonioscopy performed in room light is likely to miss many eyes with angle closure. Hence gonioscopy should be performed in dark room to avoid misdiagnosis of treatable iridiotrabecular apposition.

Comparison of results of chamber angle examination by ultrasound biomicroscopy and gonioscopy by Wang et al[24] in Zhonghua Yan Ke Za Zhi 1999 May ;35 (3): 174-8 showed 10 patients who selected for research the same eyes were examined by gonioscopy and UBM. The results from the two methods were compared. The data were analyzed by Spearman correlation test. The result of the two methods were consistent when the angle

width was wide, inconsistent when it was narrow. The angle observed by gonioscopy was wider than UBM. When peripheral iris root insertion was studied, it was difficult to distinguish functional closure from adhesive closure. When peripheral iris morphology is evaluated the influence of irregular iris might result in wrong conclusion. Therefore they concluded by gonioscopy technique of examination should be improved[38].

Yuzhen Jiang et al[23] Investigative ophthalmology and Visual science April 2010;51 :2035-2042 : Evaluated primary angle closure suspects determined by gonioscopy who were subjected to ultrasound biomicroscopy. A set of standard images were used to qualitatively classify anatomic features related to angles like iris thickness, iris convexity, iris angulations, ciliary body size and ciliary process distance .

According to data, the study factors believed to be associated with non pupillary block mechanism of angle closure were apical iris insertion, large ciliary body, and anteriorly positioned ciliary body. Angle closure occurs due to one or more anatomical abnormalities.

Anterior segment imaging: UBM by Hiroshi Ishikawa ,MD and Joel S. Schuman MD; published article in Ophthalmol Clin North Am[9,11]. New methods of imaging the angle of eyes have been introduced which offers advantages of being more objective reproducible and storage, quantitative analysis and the capacity of anterior segment imaging despite media opacities results in their easy in cooperation into clinical practise & research. New devices have their disadvantages. Dynamic indentation gonioscopy will still remain as the current standard reference for narrow angles.

Smith –method assessment of anterior chamber depth for screening for narrow anterior chamber angles by Turki M Al-Mubrad PhD; Kelechi C Ogbuehi ,PhD Indian J Ophthalmology 2006[22] In this study just touching slit lamp(JTSL) measurement of axial anterior chamber depth was determined in 198 eyes .The JTSL in primary open angle glaucoma patients was similar to control group where as in primary angle closure glaucoma there was significant reduction in JTSL. This is a non invasive rapid screening method in OPD to detect people at risk of developing

angle closure attack during routine examination of patients in ophthalmology OPD.

Role of ultrasound biomicroscopy in the detection and localisation of anterior segment foreign bodies by Sujata Guha MD; Muna Bhende MD; Annals academy of medicine, Singapore 2006;35:536-40[4]

In this study the foreign body detection rates were 36.5% by USG, 88.9% by CT scan and 94.4% by UBM. UBM is the valuable adjunct for the accurate localisation of small foreign bodies. It offers higher detection rate than that provided by USG & CT scan. The diagnosis of presence of the foreign body using UBM was made based on high reflective echoes causing shadowing or reverberation.

Alternation of anterior chamber and angle structure in eyes with primary angle closure after laser peripheral iridotomy. Lin Z ,Fan SJ, Sun X, Sun LP CHINESE article with objective to quantitatively evaluate the long term changes in anterior segment by using UBM after laser peripheral iridotomy in eyes with primary angle closure .This study showed laser peripheral

iridectomy(PI) can significantly widen the peripheral anterior angle in eyes with primary angle closure lasting for atleast 1 year after PI .Parameters detected by UBM AT 750µm anterior to scleral spur appear to be more sensitive in evaluating the alternation of peripheral angle structure.

Pavlin et al, Dept of ophthalmology in a publication of Clinical use of ultrasound biomicroscopy ophthalmology 1995 ;102(12) : Pavlin et al and colleagues attempted to define angle in degrees by proposing to draw a line through the trabecular meshwork & inferior line along the iris further development of UBM technology included the addition of eye cup may exert a compressive force on the sclera[14,15] .

Pavlin et al[14,15] presented in 1992 the techniques allowing examination of filtration angle, sclera thickness and diagnostics of ciliary body with ultrasound biomicroscopy, this paper presents a thorough analysis of changes observed in filtration angle of glaucomatous eyes.

Ultrasound biomicroscopy in the diagnosis & management of cyclodialysis cleft By Bhende M, Lekha T ,Vijaya L , Gopal L .

Indian journal of ophthalmology 1999; 47:19-23[3] Cyclodialysis cleft were accurately diagnosis and delineate in 6 eyes by UBM. Complete closure was documented after treatment in 3 eyes and a residual cleft in one eye. These findings were compared to gonioscopic findings. It was concluded in study as UBM is a safe , accurate and non invasive diagnostic tool in the diagnosis of cyclodialysis, it is of particular use when other conventional methods of diagnosis is inconclusive .

Narayanaswamy et al[13] documented that mean angle width estimation by ultrasound biomicroscopy showed poor agreement in grading the narrower angles less than 10º, which was due to the poor overlap of error bars in it. The estimation of grade 2 and grade 3 angles corresponded well by ultrasound biomicroscopy as well as gonioscopic techniques. A significant mismatch was present which was due to the poor overlay of error bars, was seen in very wide angle recess. In this study of 500 subjects, 140 were found to have mismatch detected by direct one to one analysis. 4 graded as Shaffer's in gonioscopy of which 3 were graded as 10° by ultrasound biomicroscopy. 11 angles were interchanged

between grades 1 and 2, 35 angles were graded as 20° by ultrasound biomicroscopy were classified as grade 3 by gonioscopy. 28 estimated as 40° by ultrasound biomicroscopy were classified as Shaffer's grade 3 by gonioscopy. The remaining angles were interchanged between grade 4 and 3 or vice versa.

The role of ultrasound biomicroscopy as a useful quantitative tool and qualitative tool has been evaluated. In this study, there was a likelihood of overestimating angle width by gonioscopy for slit like and grade 1 angles.

The ultrasound biomicroscopy and anterior segment OCT can both be used in evaluation of angles in glaucoma. Advantage of OCT included non contact technique, easy to learn, can be used to assess refractive surgeries on cornea. Advantage of ultrasound biomicroscopy is in better visualisation of zonules, ciliary body and pars plana.

Dada et al[6] compared anterior segment parameters using quantitative imaging by anterior segment OCT and ultrasound biomicroscopy and found comparable results.

AIMS AND OBJECTIVES

1. To compare ultrasound biomicroscopy measurement of anterior chamber angle of eyes with gonioscopy in patients attending Ophthalmology outpatient department of GOVERNMENT RAJAJI HOSPITAL, MADURAI.
2. To evaluate ability of ultrasound biomicroscopy as a predictor to diagnose early stages of glaucoma.
3. To analyse whether ultrasound biomicroscopy or gonioscopy which is to be more precise method in direct documentation of all structures involved in angle structures configuration.

MATERIALS AND METHODS

SOURCE OF DATA :

It is a hospital based comparative study. It consist of patient attending the ophthalmology out patient department in GOVT. RAJAJI HOSPITAL, MADURAI. It included patients of age group of 20 – 70 years.

METHOD OF COLLECTION OF THE DATA

STUDY DESIGN: One year comparative study of patients.

SAMPLE SIZE : **100 eyes**

SAMPLE : Patient attending the outpatient department.

Between the age group of 20–70 years.

PLACE : GOVT. RAJAJI HOSPITAL, MADURAI

DURATION : ONE YEAR.

INCLUSION CRITERIA

- Patient attending ophthalmology OPD aged between 20 -70 years
- Patient with normal cup disc ratio on funduscopy.
- Patient with clinically suspected narrow angles

EXCLUSION CRITERIA

- Patient with conjunctivitis, keratitis, uveitis.
- Patient with perforating injury.
- Patient with corneal haziness.
- Patients with previous history of glaucoma surgery, laser surgery.

METHOD:

The study was conducted on 50 patients attending out patient department of our hospital. Patients who were healthy within the age group of 20-70 years with normal intraocular pressure, normal fundus and also with suspected narrow angles were taken for the study. Patient with conjunctivitis, keratitis, uveitis, glaucoma, previous history of surgery and laser, blunt trauma were excluded from the study.

Informed consent was taken from all the participants explaining to them the procedure and the risk. The study was given ethical clearance by the ethical committee.

All patients underwent initial evaluation of vision both eye, intraocular pressure with applanation tonometry, anterior segment was evaluated using slit lamp mainly conjunctiva for any signs of infection, cornea also for infections and opacities, AC depth for assessing shallow or normal depth, iris for any change in colour and pattern, pupil reactions, lens for changes. For AC depth Van Herick's method was used.

Gonioscopy was done under standard room illumination. It was done under slit lamp with short and narrow beam avoiding the pupil. It wass done with Zeiss 4 mirror gonioscopy. With patient examined in slit lamp, gonioscopy was done using light of 2mm width. Avoid light falling in the pupillary area as it will cause false estimation of the angle grades. It was examined under high power. Shaffer's grading system was used to grade the angle into 0, 1, 2, 3 and 4. Clinically grade 2 is cut off for occludability. The above angles were further divided for comparative purpose into occludable i.e. 0, 1, 2.and non occludable 3, 4.

UBM was performed on all the patients with OTI with 35 MHz transducer probe which facilitate 4-5mm tissue penetration and has a resolution of 50µm. OTI (ophthalmologic technologies Toronto, Canada) is device probe used for ultrasound biomicroscopy, probe is light and small enough not to use suspension arm and a sector scanning method is used. It produces a 4×4mm field with 256 vertical limes at the scan of 5 frames per second.

UBM was performed under the same standard room illumination as the gonioscopy performed in supine position with eye fixing the distance. Under topical anaesthesia an ocular cup was placed filled with saline. Subject was imaged by UBM by radial scans at 12, 3, 6, 9 ‘o’clock position to obtain the image. Parameters measured were anterior chamber angle. Trabecular iris angle is defined as an angle formed with the apex at the iris recess and the arms passing through the point on the trabecular meshwork 500µm from the sclera spur and the point on the iris perpendicularly opposite according to Pavlin’s measurement[14,15]. These angles were graded into Shaffer’s grading into 0,1,2,3 and 4 grades. Further divided into occludable which included grade 0,1,2 angles and non occludable angles which included 3 and 4 grade angles..

Data of each eye of the subject were studied. Ultrasound biomicroscopic and gonioscopic data of the same eye was used for comparative analysis. Chi square was used to compare the variables and the p value of less than 0.05 was considered significant.

RESULTS

Table – 1

Age Distribution

Age in years	No.of cases	Percentage
< 40	6	12
41- 50	15	30
51- 60	23	46
> 60	6	12
Total	50	100

In our study, 100 eyes were studied of 50 patients. The age group range of 20-70. Maximum age group ranging group being 51-60 which is 46% of the study group.

AGE DISTRIBUTION

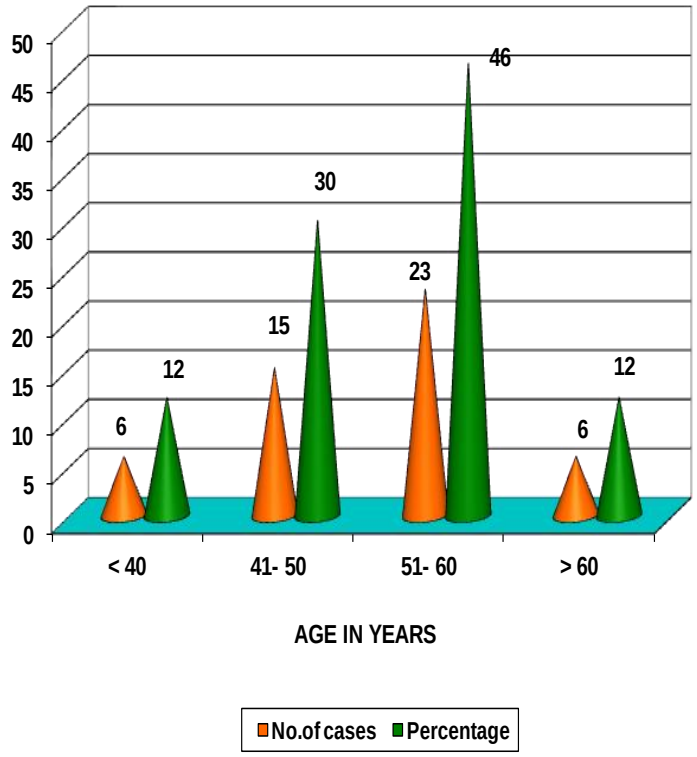


Table – 2

Sex Distribution

Sex	Number .of cases	Percentage
Male	26	52
Female	24	48
Total	50	100

In this study conducted on 50 patients attending our OPD at Govt. Rajaji hospital, out of which 26 were males accounting for 52% and 24 females accounting for 48% of the study group.

SEX DISTRIBUTION

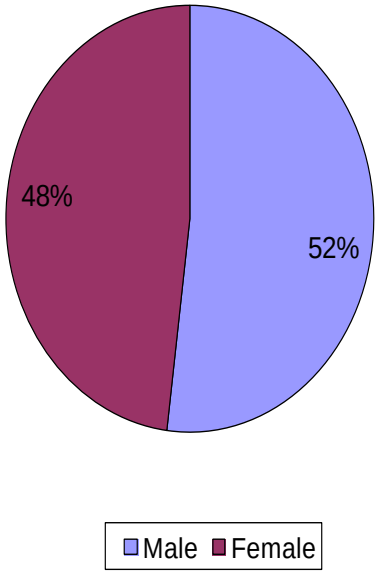


Table – 3

ANTERIOR CHAMBER DEPTH

AC	Male	Female	Total
SD	8	16	24
ND	44	32	76
Total	52	48	100

100 eyes of these patient underwent full examination diffuse light and slit lamp examination, intraocular pressure, gonioscopy and ultrasound biomicroscopy.

On slit lamp examination, 100%of the patients had normal conjunctiva, 100% had clear cornea, 100% had normal iris with round regular reacting to light pupils.

When anterior chamber depth assessment was done 24 eyes had shallow depth and 76 eyes had normal depth. Out of the 24 shallow depths 8 were males and 16 were females i.e. 66% of the study group.

AC

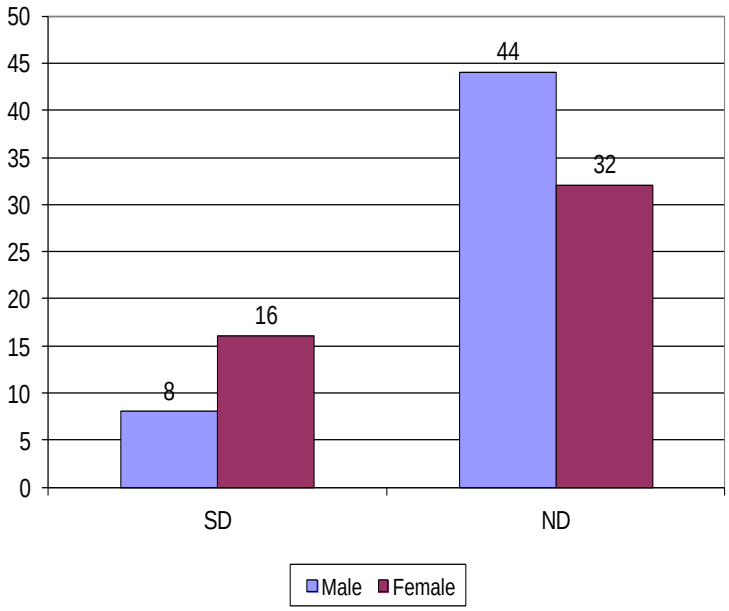


Table – 4

GONIOSCOPY

Gonioscopy	No.of eyes	Percentage
Grade 1	4	4
Grade 2	12	12
Grade 3	67	67
Grade 4	17	17
Total	100	100

Gonioscopy was done on all patients both eyes using 4 mirror gonioscopy and angles of all quadrants were graded according to Shaffer's grading under room illumination. It was found that 4% of the eyes were of grade1, 12% of eyes were of grade2, 67% of eyes were of grade3, 17% of the eyes were of grade4.

DISTRIBUTION OF EYES IN GONIOSCOPY

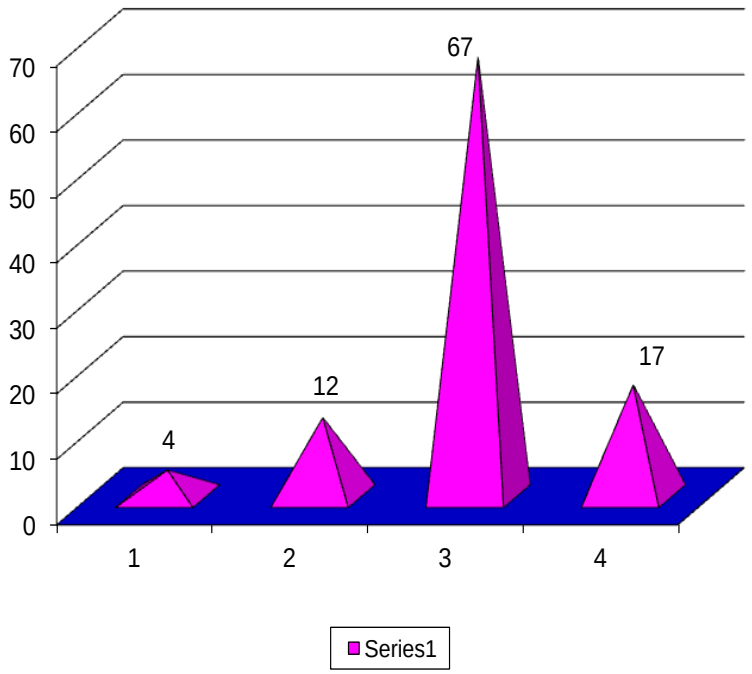


Table – 5

UBM

UBM	No.of eyes	Percentage
Grade 1	12	12
Grade 2	21	21
Grade 3	52	52
Grade 4	15	15
Total	100	100

Ultrasound biomicroscopy was evaluated for the same eyes under similar illuminating conditions using OTI scan 35 MHz probe with saline bath. It was found that of the eyes in the study group 12% were grade 1, 21% grade2, 52% grade 3,15% grade 4.

DISTRIBUTION OF EYES IN UBM

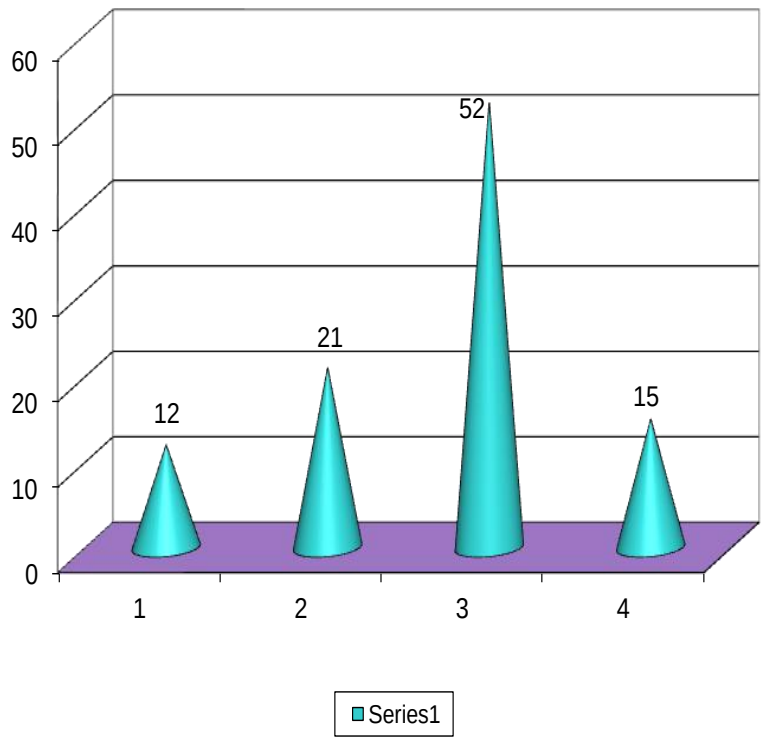


Table – 6

GONIOSCOPY

GONIOSCOPY	No.of eyes	Percentage
O	16	16
NO	84	84
Total	100	100

UBM

UBM	No.of eyes	Percentage
O	33	33
NO	67	67
Total	100	100

Gonioscopy angles were further divided into occludable consisting of grade1 and 2 accounting for 16% of the eyes studied and rest were non occludable consisting of grade3 and 4 accounting for 84% of the eyes studied for comparison purpose.

UBM angles were further divided into occludable and non occludable accounting for 33% and 67% respectively.

DISTRIBUTION OF ANGLE STATUS BY GONIOSCOPY AND UBM

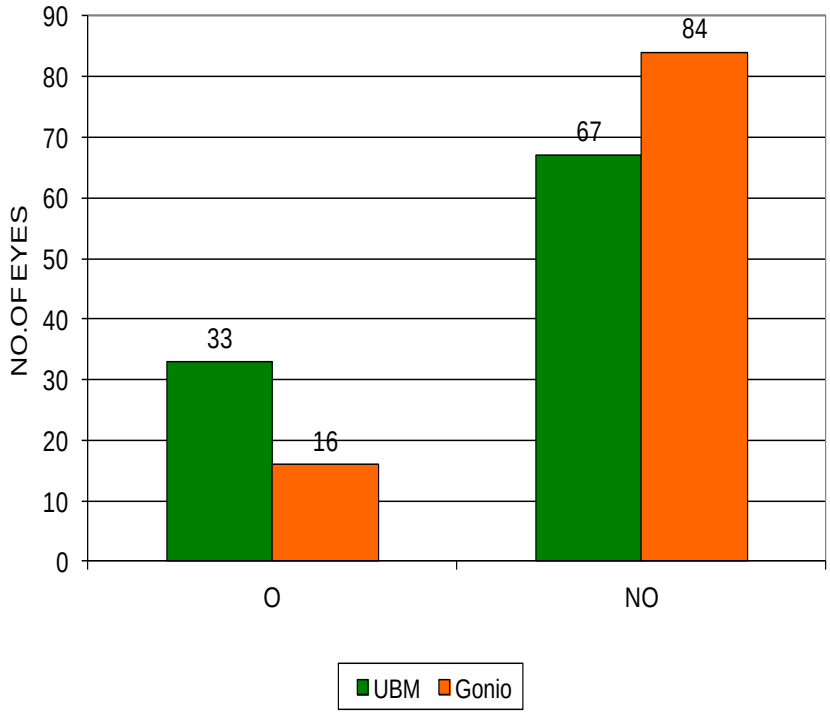


Table – 7

Gonioscopy

Gonioscopy	UBM		Total
	O	NO	
O	16	0	16
NO	17	67	84
Total	33	67	100

P value = 0.043 Significant

(for Gonio O Vs UBM O)

P value = 0.348 Not Significant

(for Gonio NO Vs UBM NO)

Chi square test was applied to the occludable and non occludable groups detected by gonioscopy and UBM. It was found to be significant for the occludable angles.

Table – 8

Gonioscopy Total No.of Grade III	UBM		
	Grade I	Grade II	Grade III
67	8	7	52

Finally certain mismatches were found as follows, out of the 67(100%)eyes graded as 3 in gonioscopy , 8(11.3%) were grade 1, 7 (10.4%) were grade 2 and 52 (77.6%) were grade3 on ultrasound biomicroscopy.

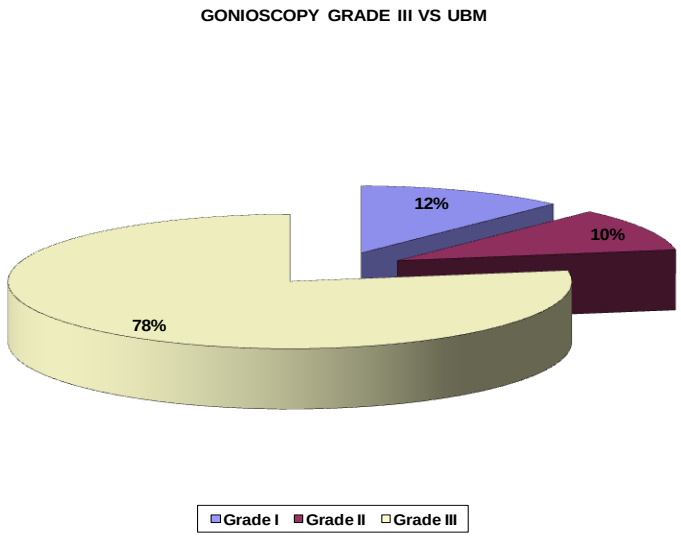
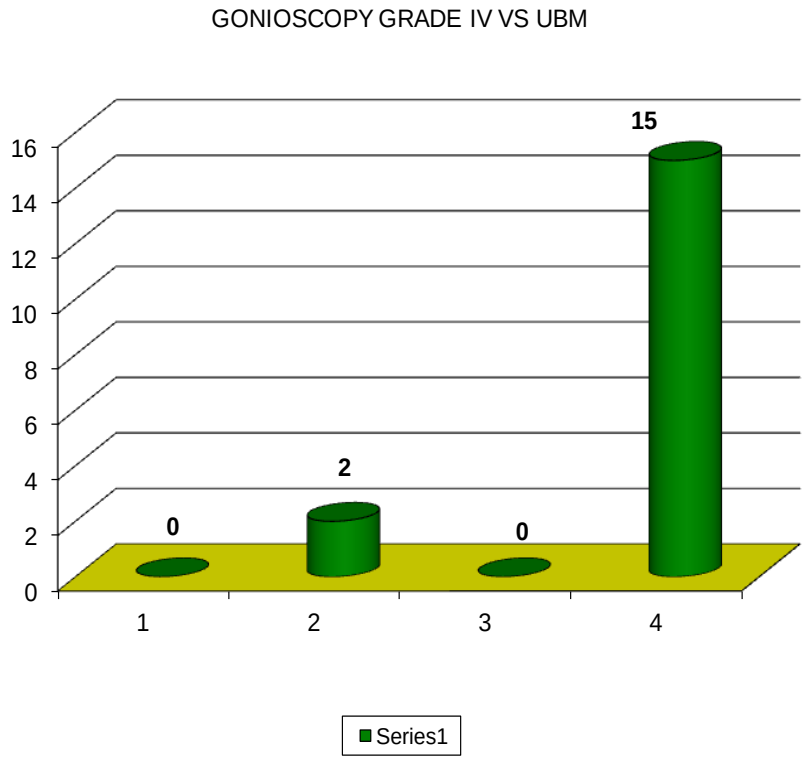


Table – 9

Gonioscopy Total No.of Grade IV	UBM			
	Grade I	Grade II	Grade III	Grade IV
17	0	2	0	15

In grade 4 on gonioscopy which were 17 (100%) eyes out of which 2 (11.76%) eyes were grade 2 and 15(18.2%) were grade 4 on ultrasound biomicroscopy.



DISCUSSION

Grading of the angle of the anterior chamber forms an essential part in assessment and screening of glaucoma. Gonioscopy and ultrasound biomicroscopy both are used as an important tool for assessment former being subjective method and the later being objective one.

Gonioscopy is the main stay at present for diagnosing narrow angles. The Shaffer's grading system[10] of the angles is the main stay of grading of angles into 4 grades can be further divided into occludable and non occludable.

In this study group 50 patients who attended our ophthalmology OPD at Govt. Rajaji hospital were studied for a period of 1 year. Patients were ranging in the age group 20-70 years, with the age group 51-60 years being the major population about 46%of the study group. This age group was comparable with Narayanasamy et al[21] were age group was 30-87 years and mean age 57.42 years. In this study population 52% were males and 48% females.

Patients were subjected to slit lamp examination and anterior chamber depth examination, 24% of the patient had shallow depth, 76% had normal depth. Females formed the major population of the shallow depth eyes about 66.66%. It corresponded to Kaushik et al[12] study 92 women and 71 males were studied and found more narrow angles in females compared to males in par with our study. The mean age in females was less than males in that study.

All the angles of both the eyes of 50 patients were subjected to gonioscopy under standard light condition. Shaffer's grading system was used for angle grading[27] same grading system was used in Kaushik et al[12], Narayanasamy et al[13], Barkan et al[3] studies in angles grading system.

In this study the incidence of patient detected grade 1 was 4%, grade 2 was 12%, grade 3 was 67% and grade 4 was 17%. Majority of these patients belonged to grade 3 which was in agreement with Narayanasamy et al[13] where it was 78.8% grade 3 and in Kaushik et al[12] 42 angles were grade 3.

The angles were then divided into occludable and non occludable which was in agreement with Narayanasamy et al[13]. The number of occludable cases in our study was 16 and non occludable was 84.

Similar to gonioscopy, ultrasound biomicroscopy was performed in the same patients under same illumination system but in supine position and the grading of the angles done by Pavlin et al[14,15] parameters using Shaffer's grading system[11]. The angles were graded into 12% as grade1, 21% as grade 2, 52% as grade 3, 15% as grade 4. They were again divided into occludable and non occludable accounting for 33% and 67% respectively. The two methods were compared by Chi square and analysed, p value was found to be significant in occludable angles.

Finally certain mismatches were found as follows, out of the 67(100%)eyes graded as 3 in gonioscopy , 8(11.3%) were grade 1, 7 (10.4%) were grade 2 and 52 (77.6%) were grade3 on ultrasound biomicroscopy. In grade 4 on gonioscopy which were 17 (100%) eyes out of which 2 (11.76%) eyes were grade 2 and 15(18.2%) were grade 4 on ultrasound biomicroscopy.

This study was in par with Wong N et al[24] the result of this study showed gonioscopy showed little wider angle than its natural status especially its difficult to distinguish functional closure from adhesion . The angle observed by gonioscopy was wider than that detected by UBM. This study was in agreement with Narayanasamy et al[13], the mean angle width estimated by Ultrasound biomicroscopy in narrow angles were seen due to poor overlap of bars, grade 2 and 3 correlated well in both gonioscopy and UBM , significant mismatch was found in wider angles due to poor overlay of bars.

In our study there was overestimation of narrow angles in gonioscopy i.e. wider angle detection of narrow angles in gonioscopy however the segregation into occludability and non occludability did not vary in both[14]. In study by Kaushik et al[12] UBM measurement significantly correlated with gonioscopic angle assessment. All UBM parameters differed significantly among the different grades of angles categorised by gonioscopy. This indicates that gonioscopy is a subjective evaluation and provides accurate estimation with regard to the angle width.

In study done by Spaeth et al[20] correlated gonioscopy and Ultrasound biomicroscopic findings in 22 eyes with variable angle width , 6 eyes found to have iridiotrabecular contact on gonioscopy , 4 had similar finding in UBM but 2 had iris contact anterior to the meshwork.

Sakuma et al[19] studied angle closure in 50% of the 46 eyes by gonioscopy which was said to be of higher percentage in UBM.

Pavlin et al[14,15] gave importance in examining the patient under same illumination as variation gave false results.

Our study was in agreement with Narayanasamy et al[13], angle depth by gonioscopy is inaccurate in narrow angles. The estimation of angles of grade2 and 3 by gonioscopy was fairly accurate. These errors did not affect the classification of the occludable and non occludable angles. Indicating it to be still a gold standard subjective test.

In our study drawback is the other parameter like angle opening distance, Trabeculociliary process distance were not measured which correlates well with the angle width. It is said to

be more useful if it measured quantitative parameters like iris and lens position , axial length and anterior chamber depth. We used a 35 MHz probe for the study than the standard 50MHz.. This procedure was done in supine position where as gonioscopy was done in sitting position.

CONCLUSION

Gonioscopy is a subjective method. It is an useful method of grading and evaluating the angles of anterior chamber of eyes. It helps in segregating into occludable and non occludable fairly accurately when done by an experienced observer.

Ultrasound biomicroscopy is a very good imaging tool for the anterior segment of the eyes as the sclera spur is a consistent finding for accurate angle measurement. It is required for quantification of angles which is a type of objective method.

In our study, it was seen that subjective assessment by gonioscopy resulted in over estimation of angle width with in occludable group when compared to ultrasound biomicroscopy but segregation of occludable angles from non occludable were not affected.

Ultrasound biomicroscopy has enabled clinicians to quantitatively asses the iris curvature and degree of angle opening since it images a cross section of angle structures. It helps in

visualisation of angle status in presence of media opacities. Useful in documentation and prognosis purpose.

To conclude, gonioscopy appears equally effective in grading of the anterior chamber angle as compared to the ultrasound biomicrosccopy. In spite of the advent of ultrasound biomicroscopy for quantitative estimation of anterior chamber angle, gonioscopy remains the standard for appositional from synechial closure. Ultrasound biomicroscopy has revolutionised the evaluation of the anterior segment of the eyes. The structures of posterior segment difficult to examine in presence of media opacities are better visualised now. In evaluation of glaucoma both investigation play a vital role with their own advantages and disadvantages[31].

SUMMARY

The present study was a comparative study conducted in department of ophthalmology in outpatient department of Govt. Rajaji Hospital, Madurai.

The objective of this test was to compare gonioscopy with ultrasound biomicroscopy for measuring the anterior chamber angle accurately. The study was done for a period of 1 year on 100 eyes of patients attending our OPD. An informed consent was obtained after explaining the risk and advantages associated with study in their own language. After meeting the inclusion and exclusion criteria patient's eyes was subjected to anterior segment evaluation with slit lamp examination, intraocular pressure, gonioscopy, ultrasound biomicroscopy for the angle assessment of the anterior chamber.

Results of the two measurements were compared. Both methods compared with the ability of each method to define occludable and non occludable. The comparison in our study proved that anterior chamber estimation of angle categorisation into occludable and non occludable was significant. Though

gonioscopy caused over estimation of angle width it will remain the standard for evaluations of angle of anterior chamber. However ultrasound biomicroscopy though costly, it is required for objective quantification of the angles. Widespread and mandatory use of gonioscopy in evaluation of eyes will help in reducing the morbidity from angle closure glaucoma by early detection and intervention. Gonioscopy and Ultrasound biomicroscopy are equally effective.

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PROFORMA

1. Name :

2. Age / Sex :

3. Address :

4. Hospital Number:

5. Vision : Right

Left

6.Intraocular pressure with APPLANATION TONOMETER:

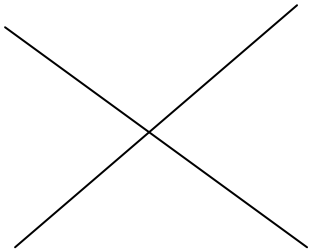
	Right	Left

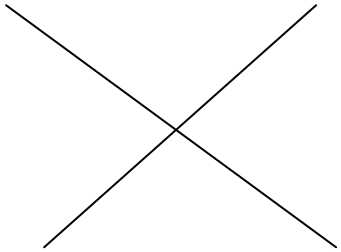
7.Anterior segment:

	RIGHT	LEFT
Conjunctiva		
Cornea		
AC depth		
Iris		
Pupil		
Lens		
Van-Herick's grading of AC		

8. Gonioscopy findings

RIGHT **LEFT**





9. UBM findings

RIGHT : SUPERIOR

NASAL

INFERIOR

TEMPORAL

LEFT : SUPERIOR

NASAL

INFERIOR

TEMPORAL

10. Central AC depth :

MASTER CHART

No.	Name	Age	sex	conj	cornea	AC	IRIS	PUPIL	LENS	V - H	GR.SUP	GR.INF	GR.NAS	GR.TEM		GR O/NO	GL.SUP	GL.INF	GL.NAS	GL.TEMP		GL O/NO	UR.SUP	UR.INF	UR.NAS	UR.TEMP		UR O/NO	UL SUP	UL.INF	UL.NAS	UL.TEM		UL O/NO
1	KANAN	40	M	N	C	ND	N	Y	Y	4	3	3	3	3	3	NO	3	3	3	3	3	NO	2	2	2	2	2	O	2	2	2	2	2	O
2	JAYA	44	F	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	3	3	3	NO	2	2	2	2	2	O	2	2	2	2	2	O
3	PYARI JAAN	45	F	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	3	3	3	NO	2	1	2	2	2	O	2	2	2	2	2	O
4	PETCHIAMMAL	50	F	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	3	2	3	NO	2	1	2	2	2	O	3	3	3	3	3	NO
5	ALAGAR	47	M	N	C	ND	N	Y	N	4	2	4	4	4	4	NO	2	3	3	3	3	NO	2	2	1	2	2	O	3	2	3	3	3	NO
6	MEEENAKSHI	56	F	N	C	SD	N	Y	N	2	1	1	1	2	1	O	1	1	1	2	1	O	1	1	1	1	1	O	1	1	1	1	1	O
7	ALAGAMMAL	36	F	N	C	ND	N	Y	Y	4	4	4	4	4	4	NO	3	4	4	4	4	NO	4	4	4	4	4	NO	2	2	2	2	2	O
8	MUTHUPILLAI	50	F	N	C	SD	N	Y	N	2	1	1	1	2	1	O	1	1	1	1	1	O	1	1	1	1	1	O	1	1	1	1	1	O
9	MARIMUTHU	37	M	N	C	ND	N	Y	Y	4	4	3	4	4	4	NO	2	4	4	4	4	NO	4	4	4	4	4	NO	4	4	4	4	4	NO
10	KARUPAYEE	53	F	N	C	ND	N	Y	N	4	4	4	4	4	4	NO	4	4	4	4	4	NO	4	4	4	4	4	NO	4	4	4	4	4	NO
11	SUSHEELA	49	F	N	C	SD	N	Y	N	2	1	2	2	2	2	O	2	2	2	2	2	O	2	2	1	2	2	O	2	2	2	2	2	O
12	VIJAYLAKSHMI	60	F	N	C	ND	N	Y	N	4	4	4	3	4	4	NO	4	3	4	4	4	NO	4	3	4	4	4	NO	4	3	4	4	4	NO
13	KARUPAN	65	M	N	C	ND	N	Y	N	4	3	4	4	4	4	NO	3	4	4	4	4	NO	3	4	4	4	4	NO	3	4	4	4	4	NO
14	AYYAVU	54	M	N	C	SD	N	Y	N	2	2	2	2	2	2	O	2	2	2	2	2	O	3	2	2	2	2	O	3	2	2	2	2	O
15	POODUMPONNU	58	F	N	C	SD	N	Y	N	2	2	2	2	2	2	O	2	2	2	2	2	O	2	2	2	2	2	O	2	2	2	2	2	O
16	KARUPASAMEE	42	M	N	C	ND	N	Y	Y	4	4	4	2	3	4	NO	4	4	4	4	4	NO	4	4	4	4	4	NO	4	4	4	4	4	NO

17	SHAKTHI VEL	48	M	N	C	ND	N	Y	N	4	2	4	4	4	4	NO	4	4	4	4	4	NO	4	4	4	4	4	NO	4	4	4	4	4	NO
18	VIJAY	53	M	N	C	SD	N	Y	N	2	2	2	2	1	2	O	2	2	2	2	2	O	2	2	2	2	2	O	2	2	2	2	2	O
19	PERUMAL	52	M	N	C	ND	N	Y	N	4	4	3	4	4	4	NO	4	4	4	4	4	NO	4	4	4	4	4	NO	4	4	4	4	4	NO
20	GOVINDASAMI	58	M	N	C	ND	N	Y	N	4	3	3	3	4	3	NO	3	3	3	3	3	NO	3	3	3	2	3	NO	3	3	3	2	3	NO
21	VADIVEL	65	M	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
22	KARTHIK	60	M	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	2	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
23	MUNIYAMMAL	52	F	N	C	SD	N	Y	N	2	2	2	2	3	2	O	2	2	2	2	2	O	2	3	2	2	2	O	2	3	2	2	2	O
24	PEYAMMAL	66	F	N	C	ND	N	Y	N	4	3	3	3	2	3	NO	3	3	3	2	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
25	SHABARIDAS	62	M	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	2	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
26	AAROGYASAMI	57	M	N	C	SD	N	Y	N	2	2	2	2	2	2	O	2	2	1	2	2	O	2	2	2	1	2	O	2	2	2	1	2	O
27	ANDI	60	M	N	C	SD	N	Y	N	2	3	3	3	3	3	NO	3	3	3	3	3	NO	1	1	1	2	1	O	1	1	2	1	1	O
28	RUKUMANI	48	F	N	C	SD	N	Y	N	2	3	3	3	3	3	NO	3	3	3	3	3	NO	1	1	1	1	1	O	1	1	1	1	1	O
29	SHAHUL HAMEED	44	M	N	C	ND	N	Y	Y	4	3	3	3	3	3	NO	3	3	3	3	3	NO	2	3	3	3	3	NO	2	3	3	3	3	NO
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31	KATHAN	60	M	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	2	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
32	KATTAYAN	59	M	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
33	MURUGALAKSHMI	47	F	N	C	SD	N	Y	N	2	3	3	2	3	3	NO	3	3	3	2	3	NO	2	1	1	1	1	O	1	1	1	1	1	O
34	PERUMAYEE	35	F	N	C	ND	N	Y	Y	4	2	3	3	3	3	NO	3	3	3	2	3	NO	2	3	3	3	3	NO	3	2	3	3	3	NO
35	SAROJA	37	F	N	C	ND	N	Y	Y	4	3	2	3	3	3	NO	2	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
36	LAKSHMI	44	F	N	C	ND	N	Y	Y	4	3	3	3	2	3	NO	2	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
37	CHINNAMMAL	55	F	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	2	3	NO

38	MOPPAN	59	M	N	C	ND	N	Y	N	4	2	3	3	3	3	NO	3	2	3	3	3	NO	3	3	3	3	3	NO	3	2	3	3	3	NO
39	KASI	68	M	N	C	ND	N	Y	N	4	3	3	3	2	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
40	JOHN	62	M	N	C	ND	N	Y	N	4	3	3	3	2	3	NO	3	2	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
41	JEYALAKSMI	44	F	N	C	ND	N	Y	Y	4	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
42	KALYANI	45	F	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	2	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
43	ESHWARI	60	F	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	2	3	3	NO	3	3	3	2	3	NO	3	3	2	3	3	NO
44	CHINNAPPA	56	M	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	3	3	3	NO	3	2	3	3	3	NO	2	3	3	3	3	NO
45	RAJALAKSHMI	60	F	N	C	ND	N	Y	N	4	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	2	3	NO	3	3	3	2	3	NO
46	VETRI SELVI	58	F	N	C	SD	N	Y	N	2	3	3	3	3	3	NO	3	3	3	3	3	NO	1	1	1	1	1	O	1	1	1	1	1	O
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49	SARAVANA KUMAR	55	M	N	C	ND	N	Y	N	4	2	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO	3	3	3	3	3	NO
50	SANTHANA LAKSMI	34	F	N	C	ND	N	Y	Y	4	3	3	3	3	3	NO	3	3	3	3	3	NO	2	3	3	3	3	NO	3	3	3	3	3	NO

ABBREVIATIONS

AC	:	anterior chamber
UBM	:	ultrasound biomicroscopy
AOD	:	angle opening distance
TCPD	:	trabecular ciliary process distance
CB	:	ciliary body
SS	:	sclera spur
TM	:	trabecular meshwork
SL	:	Schwalbe’s line
PC	:	posterior chamber
TIAθ	:	trabecular iris angle
ID	:	iris thickness
PAC	:	peripheral anterior chamber depth
CT	:	corneal thickness
O	:	occludable
NO	:	non occludable

MASTER CHART KEYS

1.1 : serial no.

1.2 : name of the patient

1.3 : age of the patient

1.4 : sex of the patient

M: male F: female

2. Slit lamp examination of the anterior segment

2.1 conjunctiva : normal- Y - yes , N - no

2.2 cornea: clear, C – clear , H – hazy

2.3 anterior chambers. ND: normal depth, SD: shallow depth

2.4 iris. N – normal pattern , M – muddy pattern

2.5 pupil Round regular reactive, Y – yes , N - no

2.6 lens clear Y – yes , N – no (catractous)

2.7 van herick's method

1 - grade 1: PAC< ¼ OF CT

2 - grade 2: PAC= ¼ OF CT

3 - grade 3: PAC= ¼- ½ OF CT

4 - grade 4: PAC> ¼ OF CT

GONIOSCOPIC FINDINGS:

RIGHT EYE ANGLES

3.1 SUPERIOR : 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4.

3.2 NASAL: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

3.3 INFERIOR: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

3.4 TEMPORAL: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

LEFT EYE ANGLES

3.5 SUPERIOR : 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4.

3.6 NASAL: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

3.7 INFERIOR: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

3.8 TEMPORAL: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

UBM FINDINGS:

RIGHT EYE ANGLES

4.1 SUPERIOR : 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4.

4.2 NASAL: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

4.3 INFERIOR: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

4.4 TEMPORAL: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

LEFT EYE ANGLES

4.5 SUPERIOR : 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4.

4.6 NASAL: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

4.7 INFERIOR: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

4.8 TEMPORAL: 0:grade0; 1:grade1; 2:grade2; 3:grade3; 4:grade4

Ref. No. 3104/E4/3/2012

Govt.Rajaji Hospital,Madurai.20.
Dated: .03.2012

Institutional Review Board / Independent Ethics Committee.
Dr. A. Edwin Joe, M.D (FM), BL.,
Dean, Madurai Medical College & 2521021 (Secy)
Govt Rajaji Hospital, Madurai 625020.
Convenor
grhethicssecy @gmail.com.

Sub: Establishment-Govt. Rajaji Hospital, aMadurai-20-
Ethics committee-Meeting Agenda-communicated-regarding.

The Ethics Committee meeting of the Govt. Rajaji Hospital, Madurai was held at 11.00 Am to 1.00Pm on 29.03.2012 at the Dean Chamber, Govt. Rajaji Hospital, Madurai. The following members of the committee have been attended the meeting.

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1. Dr.N.Vijayasankaran,M.ch(Uro.) 094-430-58793 0452-2584397	Sr.Consultant Urologist Madurai Kidney Centre, Sivagangai Road,Madurai	Chairman
2. Dr.P.K. Muthu Kumarasamy, M.D., 9843050911	Professor & H.O.D of Medical, Oncology(Retired)	Member Secretary
3. Dr.T.Meena,MD 094-437-74875	Professor of Physiology, Madurai Medical College	Member
4. Dr. S. Thamilarasi, M.D (Pharmacol)	Professor of pharmacology	
5. Dr.Moses K.Daniel MD(Gen.Medicine) 098-421-56066	Professor of Medicine Madurai Medical College	Member
6. Dr.M.Gobinath,MS(Gen.Surgery)	Professor of Surgery Madurai Medical College	Member
7. Dr.S. Dilshadh, MD(O&G) 9894053516	Professor of OP&Gyn Madurai Medical College	Member
8. Dr.S.Vadivel Murugan., M.D, 097-871-50040	Professor of Medicine Madurai Medical College	Member
9. Shri.M.Sridher,B.sc.B.L. 099-949-07400	Advocate, 2, Deputy collectors colony 4th street KK Nagar, Madurai-20.	Member
10. Shri.O.B.D.Bharat,B.sc., 094-437-14162	Businessman Plot No.588, K.K.Nagar,Madurai.20.	Member
11.Shri. S.sivakumar,M.A(Social) Mphil 093-444-84990	Sociologist, Plot No.51 F.F, K.K Nagar, Madurai.	Member

Following Projects were approved by the committee

Sl. No	Name of P.G.	Course	Name of the Project	Remarks
1.	Pallavi Kamath,	PG, M.S (Ophthal)	Gonioscopy vs. ultrasonic bio-microscopy for measurig angle of anterior chambers	Approved

Please note that the investigator should adhere the following: She/He should get a detailed informed consent from the patients/participants and maintain Confidentially.

1. She/He should carry out the work without detrimental to regular activities as well as without extra expenditure to the institution to Government.
2. She/He should inform the institution Ethical Committee in case of any change of study procedure site and investigation or guide.
3. She/He should not deviate for the area of the work for which applied for Ethical clearance. She/He should inform the IEC immediately, in case of any adverse events pr Serious adverse reactions.
4. She/he should abide to the rules and regulations of the institution.
5. She/He should complete the work within the specific period and apply for if any Extension of time is required She should apply for permission again and do the work.
6. She/He should submit the summary of the work to the Ethical Committee on Completion of the work.
7. She/He should not claim any funds from the institution while doing the word or on completion.
8. She/He should understand that the members of IEC have the right to monitor the work with prior intimation.

DEAN

To
All the above members and Head of the Departments concerned.
All the Applicants.